What is claimed is:

Sub A7

1. A method of interrogating at least one fiber optic sensor, the sensor coupled to the pipe and sensing at least one parameter of a fluid in a pipe, the method comprising:

generating successive light pulses;

splitting the light pulses into first light pulses and second light pulses;

delaying the second light pulses a known time period relative to the first pulses;

combining the first and second light pulses onto a single optical fiber; directing the first and second light pulses through a first periodic grating of low reflectivity, through the optical sensor and through a second periodic grating of low reflectivity;

receiving reflected first light pulses and reflected second light pulses from the first grating;

receiving reflected first light pulses and reflected second light pulses from the second grating; and

determining a phase shift between the reflected first light pulses from the second grating and the reflected second light pulses from the first grating.

2. The method of claim 1 further comprising:

comparing the phase shift from the successive pulses; and determining a change in magnitude of the measured parameter from the comparison of the successive phase shifts.

3. The method of claim 1 further comprising impressing a modulation carrier onto the first light pulses.

4. The method of claim 1 further comprising directing the first and second light pulses along the optical fiber and through an optical splitter.

5. The method of claim 1 wherein the receiving reflected first light pulses and reflected second light pulses from the first grating and receiving reflected first light pulses and reflected second light pulses from the second grating comprises directing the reflected first and second pulses through an optical splitter and impinging the reflected first and second pulses upon an optical receiver.

6. The method of claim 1 further comprising directing the second light pulses through a time delay device.

7. The method of claim 1 wherein the known time period of delay is about the same as the double-pass time of the light pulses through the sensor.

8. The method of claim 1 wherein generating light pulses comprises using a continuous output DFB laser and an integrated optics chip.

9. The method of claim 1 wherein generating light pulses comprises generating light pulses of about 1 μsec in duration.

10. The method of claim 1 wherein the known time period is about 1 μsec.

11. The method of claim 1 wherein the first and second periodic gratings are tailored to reflect light having a wavelength of about 1545 nm.

12. The method of claim 1 wherein the successive pulses are generated at about 16 μsec intervals.

13. An apparatus for interrogating at least one interferometric fiber optic sensor, the sensor optically connected between a pair of reflective gratings and further coupled to a pipe, the apparatus comprising:

a light source;

a first optical coupler optically connected to the light source;

a first optical path optically connected to the coupler and including a time delay device;

a second optical path optically connected to the coupler;

a second coupler optically connected to the first and second optical paths;

a directional coupler optically connected to the second coupler;

an optical transmission cable optically connected to the optical circulator and optically connected to the at least one interferometric fiber optic sensor;

a photo receiver optically connected to the circulator; and

an interrogator connected to the photo receiver.

14. The apparatus as set forth in claim 13 wherein the second optical path includes a modulation carrier device.

15. The apparatus as set forth in claim 13 further comprising an optical amplifier optically connected thereto.

16. The apparatus as set forth in claim 13 wherein the time delay has an optical length and the sensor has a nominal optical length and wherein the optical length of the time delay is substantially the same as twice the nominal optical length of the sensor.

17. The apparatus as set forth in claim 13 wherein the pipe includes a fluid flowing therethrough, and wherein the at least one sensor comprises:

an acoustic signal sensing array having a plurality of sensors, each sensor wrapped a plurality of turns around a circumference of the pipe;

wherein optical power sent from the light source connected to the apparatus travels into the acoustic signal sensing array and reflected pulses are received by the photo receiver relating to an acoustic signal;

a local pressure variation sensing array having a plurality of sensors, each sensor wrapped a plurality of turns around the circumference of the pipe; and

wherein optical power sent from the light source connected to the apparatus travels into the acoustic signal sensing array and reflected pulses are received by the photo receiver relating to the local pressure variation.

18. The apparatus of claim 17, wherein the reflective gratings reflect the same nominal wavelength.

19. The apparatus of claim 18, wherein the reflective gratings are fiber Bragg Gratings.

20. The apparatus of claim 17, wherein the sensors within the acoustic signal sensing array are spaced to sense acoustic signals traveling at the speed of sound through the fluid, and the first signal relating to the acoustic signals can be used to determine a speed of sound for the fluid within the pipe.

21. The apparatus of claim 17, wherein the sensors within the acoustic signal sensing array are spaced a known or determinable distance or distances apart.

22. The apparatus of claim 21, wherein the sensors within the acoustic signal sensing array are spaced equidistant.

23. The apparatus of claim 17, wherein the sensors within the local pressure variation sensing array are spaced to sense local pressure variations traveling with the fluid flow, and the reflected pulses relating to the local pressure variations can be used to determine a velocity for the fluid flow within the pipe.

24. The apparatus of claim 23, wherein the sensors within the local pressure variation sensing array are spaced a known or determinable distance or distances apart.

25. The apparatus of claim 24, wherein the sensors within the local pressure variation sensing array are spaced equidistant.

26. The apparatus of claim 13 wherein the photo receiver comprises a tri-mask splitter each optically connected to a photo receiver.

27. The apparatus of claim 13 wherein the light source comprises a continuous output DFB laser and an integrated optics chip to gate the light on and off at predetermined intervals.

28. The apparatus of claim 27 wherein the intervals are about 1 μsec in duration.

29. The apparatus of claim 13 wherein the gratings are tailored to reflect light having a wavelength of about 1545 nm.

30. The apparatus of claim 13 wherein the optical length of the time delay is substantially and the nominal optical length of the sensor are each about 1 μsec

31. The apparatus of claim 27 wherein the intervals are about 16 μsec apart.

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